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SeagrassNet Monitoring in Great Bay, New Hampshire, 2016

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Frederick T Short, Ph.D., September 28 2017
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Introduction

SeagrassNet is a global monitoring program begun in 2001 and designed to scientifically detect and document seagrass habitat change (Short et al. 2006a, 2014). Monitoring of eelgrass (*Zostera marina* L.) in the Great Bay Estuary using SeagrassNet was conducted in Portsmouth Harbor between 2001 and 2009 (Short et al 2006b, Rivers and Short 2007), and in Great Bay starting in 2007 (Short et al. 2009). Results from SeagrassNet 2016, conducted in Great Bay, are described in this report. This project was funded, in part, by NOAA's Office for Coastal Management under the Coastal Zone Management Act in conjunction with the NH Department of Environmental Services Coastal Program and the University of New Hampshire.

Following the standard SeagrassNet protocol (Short et al. 2006a) used worldwide, a permanent SeagrassNet site was established in Great Bay (Figure 1) in 2007. For SeagrassNet, a "site" consists of three permanent, parallel, 50 m transects (referred to as A, B and C). For the Great Bay site, designated as site NH9.2, transect A is closest to shore and shallowest, and C is furthest from shore and deepest (Figure 2).

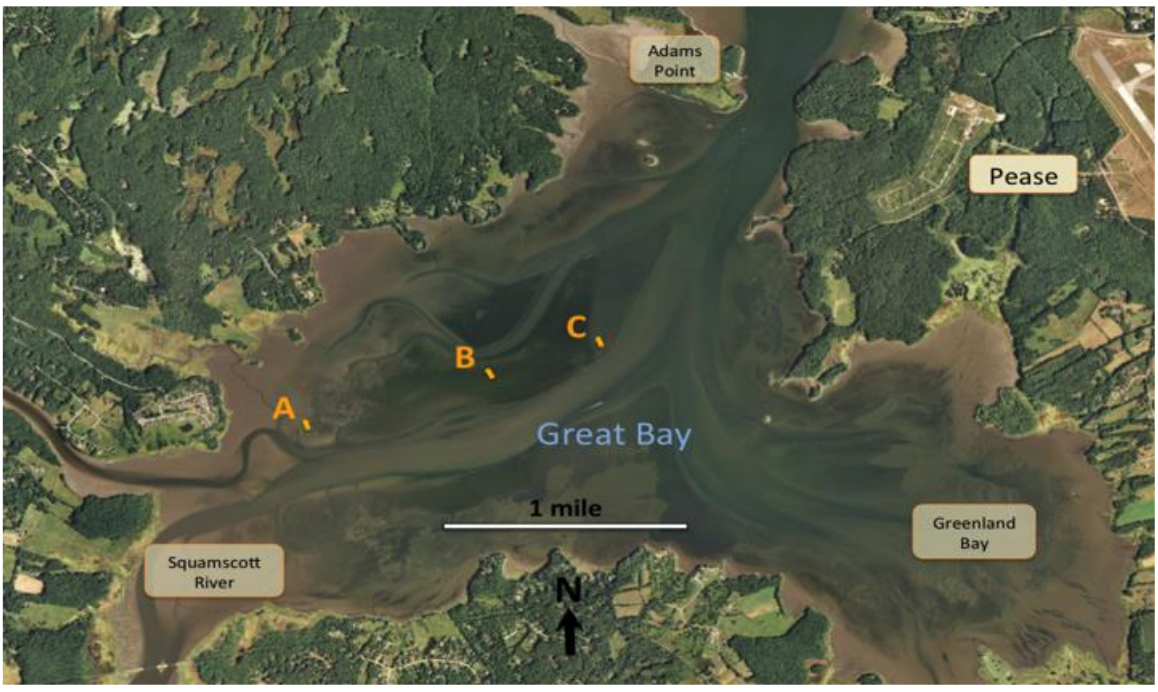

Figure 1. SeagrassNet monitoring site with Transects A, B and C in Great Bay, New Hampshire.

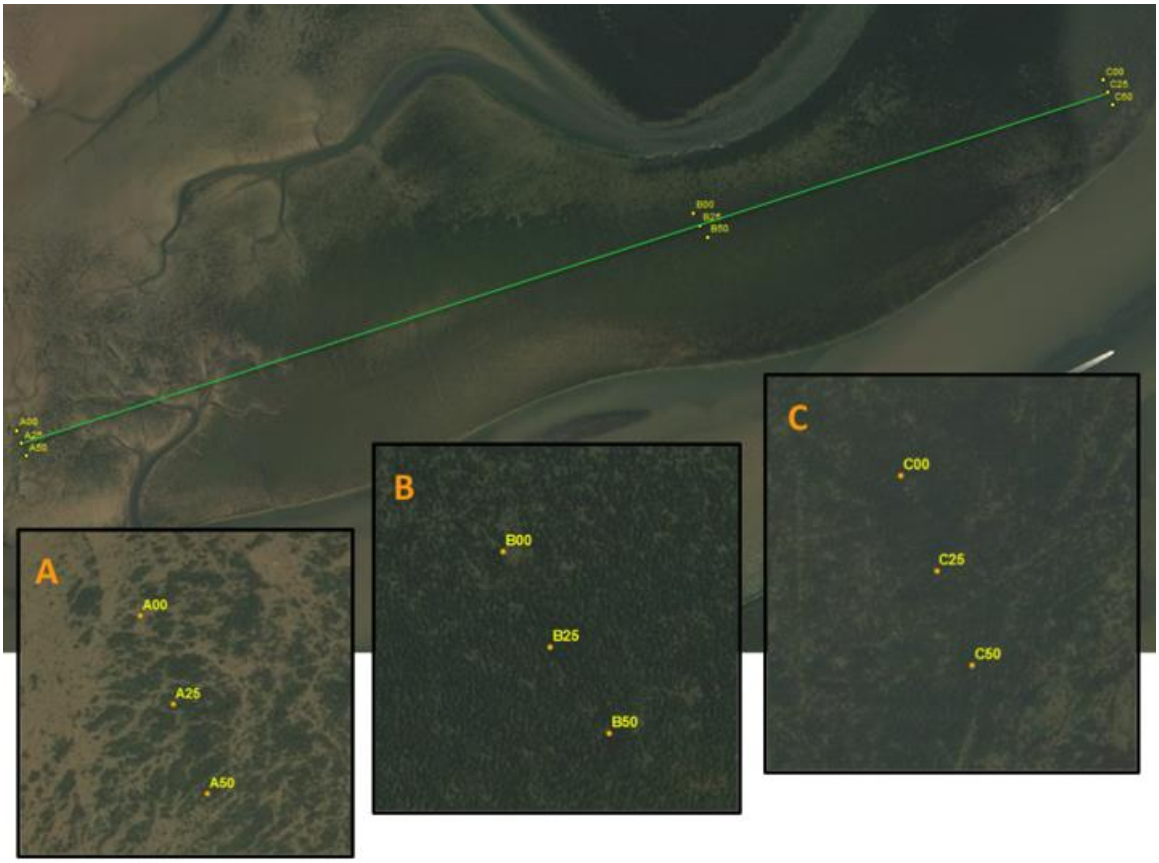

Figure 2. SeagrassNet monitoring transects, using GPS-identified points for each end and the midpoint of permanent Transects A, B and C in Great Bay, New Hampshire.

In 2016, as called for by the SeagrassNet protocol, quarterly sampling (April, July, October) was done at 12 0.25m^2 quadrats placed along each of the three transects (Figure 3). SeagrassNet sampling parameters for each quadrat include: photographic record; percent cover; canopy height; biomass; shoot density; and sexual reproduction (flowering shoots). The position of the quadrats along each transect was assigned during the development of the SeagrassNet protocol using a random number generator (www.SeagrassNet.org) and does not change, providing repeated measure assessment of specific parts of the eelgrass bed over time.

The sampling in Great Bay was conducted on April 26-27, 2016, July 4-6, 2016, October 24-26, 2016, and April 29-30, 2017. In April 2016, only a few shoots of eelgrass were present at any of the three transects. Additionally, water clarity was very poor at all three transects making photo documentation impossible. The only visual documentation that could be obtained was underwater video at Transect B; it was impossible to accurately place and photograph the sampling quadrats. With the exception of the photo documentation, all sampling in 2016 and April 2017 was done according to the SeagrassNet protocol (Short et al. 2006a, 2014). In Figures 4 and 5 and Appendix 1, below, as a frame of reference and to extend the data to the next year, the April 2017 SeagrassNet data is included.

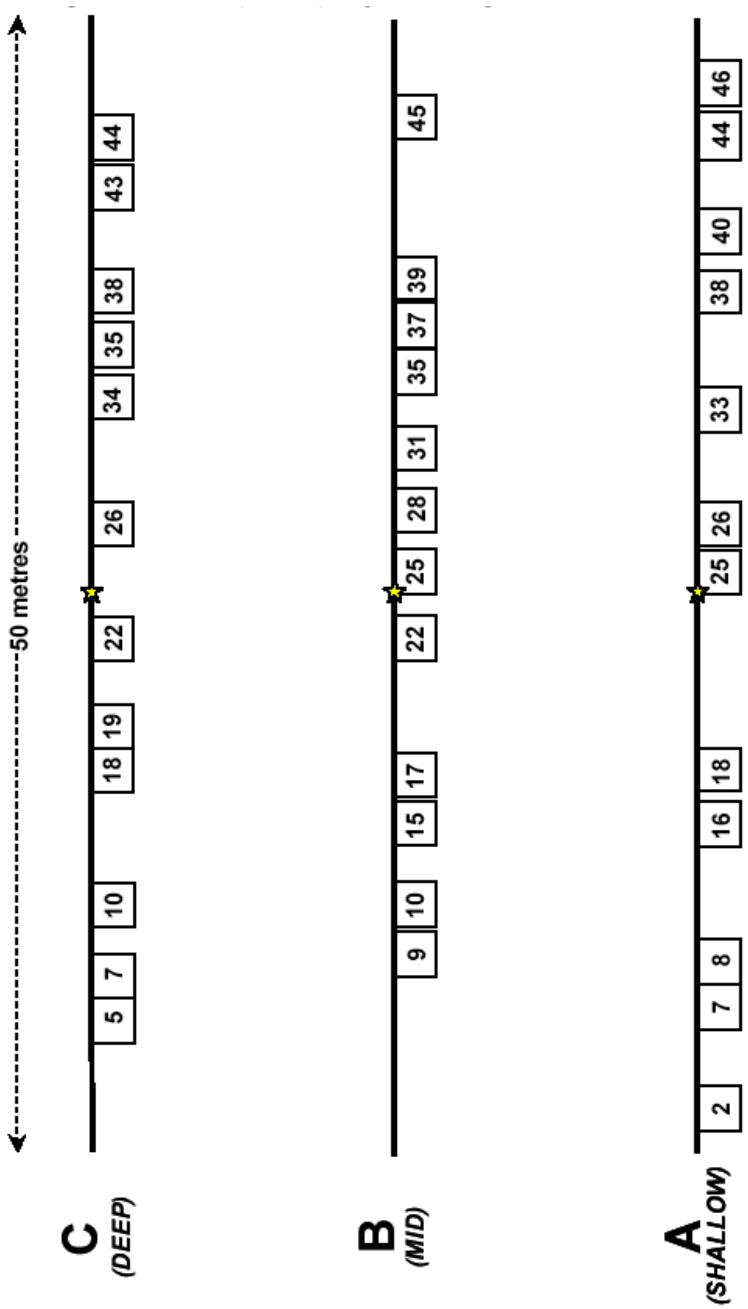

Figure 3. Location of the 12 SeagrassNet quadrats along the 50 m transects. Each square represents a quadrat. Numbers indicate the meter distance along each transect where the quadrats are positioned for sampling. The stars represent the midpoint of each transect.

Results: 2016 SeagrassNet Data

SeagrassNet Quadrat Photos

The 2016 photos of Transects A, B, and C were compiled in photo mosaics, allowing a visual assessment of the SeagrassNet site in Great Bay (Appendix 2).

During the course of 2016, the quadrat photos revealed changes in eelgrass percent cover at all three transects. On Transect A, April 2016, most of the quadrats had no live eelgrass; no photos were taken on Transect A in April because of extremely turbid conditions. In July, most of the Transect A quadrats had scattered eelgrass cover; in October, all of the quadrats along Transect A had large amounts of seaweed and very little eelgrass was present (Appendix 2).

Transect B quadrat photos for April 2016 show no eelgrass except single shoots in three quadrats (Appendix 2). In July at Transect B, five quadrats had enough eelgrass to cover most of the quadrat, five had small patches of eelgrass, and two had moderate amounts of eelgrass. In October at Transect B, most quadrats had complete eelgrass cover, many with some seaweed.

At Transect C in April 2016, no photos were taken because of highly turbid conditions, but a visual survey of the transect showed no eelgrass present. By July, there was complete eelgrass cover at almost all the Transect C quadrats (Appendix 2). In October, there was dense eelgrass cover in many of the Transect C quadrats, with some seaweed.

Eelgrass Percent Cover

Percent cover is a measure of how much of the quadrat is covered by seagrass on a scale of 0 – 100%, using a percent cover guide, a standard scientific field technique for vegetation measurements. Transect A showed very little eelgrass throughout 2016, with less than 5% cover all year, compared to 2015 when Transect A reached over 30% cover in July. As in 2015, Transect B in 2016 reached its maximum eelgrass percent cover in October. Transect C, which started in April with just under 40% cover, had relatively high percent cover from July through October 2016 (Figure 4 and Appendix 1), in a somewhat different pattern than 2015 (Short 2017a). Overall, the averaged annual 2015 and 2016 cover data for the three transects combined showed very similar percent cover maxima, both in October and both about 35% (Figure 5).

Eelgrass Shoot Density

Shoot density was extremely low throughout 2016 at Transect A. Transects B and C had much higher shoot density (Figure 4). Overall, shoot density in 2016 was slightly lower than in 2015 (Short 2017a; Figure 5).

Eelgrass Canopy Height
Transects A and B had similar canopy height in 2016 and showed a similar annual pattern, very similar to 2015. Eelgrass at Transect C had substantially greater canopy height than either A or B and peaked in July 2016, with more than 1m average canopy height, higher than 2015 (Short 2017a; Figure 4). Overall, canopy height was similar for July and October of 2015 and 2016 (Figure 5).

Eelgrass Flowering
Flowering in 2016 was greatest at Transect B in July with 20 flowering shoots per m^2. Transects A and C had fewer than 10 flowering shoots per m^2 in July (Figure 4). At Transect C, low flowering is typical because of the water depth, while at Transect A, low flowering in 2016 was a result of the very low eelgrass shoot density and low percent cover throughout the year. Overall, flowering was lower in 2016 than 2015 (Short 2017a), with no flowering in October 2016, unlike 2015 which had 5% flowering shoots in October (Figure 5).

Seaweeds at the SeagrassNet Transects
The predominating seaweed occurring along the SeagrassNet transects in 2016 was *Gracilaria vermicuphyllum*, an invasive species in Great Bay. *Gracilaria vermicuphyllum* was present in July in all Transect A quadrats. By October, it completely covered most of the quadrats on Transect A, with only a few eelgrass shoots present. Some *G. vermicuphyllum* was also seen at Transects B and C in October, entangled at the base of the eelgrass shoots. Overall, the seaweed cover in 2016 was greatest at Transect A and greater than 2014 (Short 2014). The big difference between the seaweed present in 2014 vs. 2016 was that in 2014, *Ulva lactuca* was the dominant species in the quadrats while in 2016, the invasive *G. vermicuphyllum* dominated (Figure 6).

Discussion

Typical eelgrass in a healthy, clear water environment in New Hampshire and southern Maine attains maximum canopy height in late summer and autumn (Gaeckle and Short 2003) while the greatest shoot density occurs in July (Ochieng et al. 2010), consistent with what was observed in 2015 (Short 2017a) but not in 2016 at the SeagrassNet site in Great Bay. In the past (going back to 2007) at the Great Bay SeagrassNet site, percent cover at all transects reached 100% by July and continued at near 100% through October (Short 2017b). In 2016, however, mean percent cover for all transects combined was less than 30% in July. By October, percent cover only reached 34%.

In 2016, unlike many recent years when eelgrass has not survived the winter, there was some overwintering eelgrass at all three SeagrassNet transects in the spring. All plant parameters therefore started the growing season at higher levels in 2016 than in 2015 (or than in 2017, Figure 5). Nonetheless, eelgrass parameter values throughout the 2016 growing season were, on the whole, lower than 2015. Particularly at Transect A, seaweed

outcompeted eelgrass, with almost no eelgrass at this transect throughout 2016, and almost complete cover of seaweed (Figure 6). Flowering was low throughout the year and near zero at all transects by October 2016.

Monitoring using the SeagrassNet protocol revealed low values of eelgrass shoot density, canopy height and flower density compared to Great Bay in the late 1980s (Short et al. 1993), although these eelgrass parameters were not vastly different than the SeagrassNet data for 2015 (Figure 5, Short 2017).

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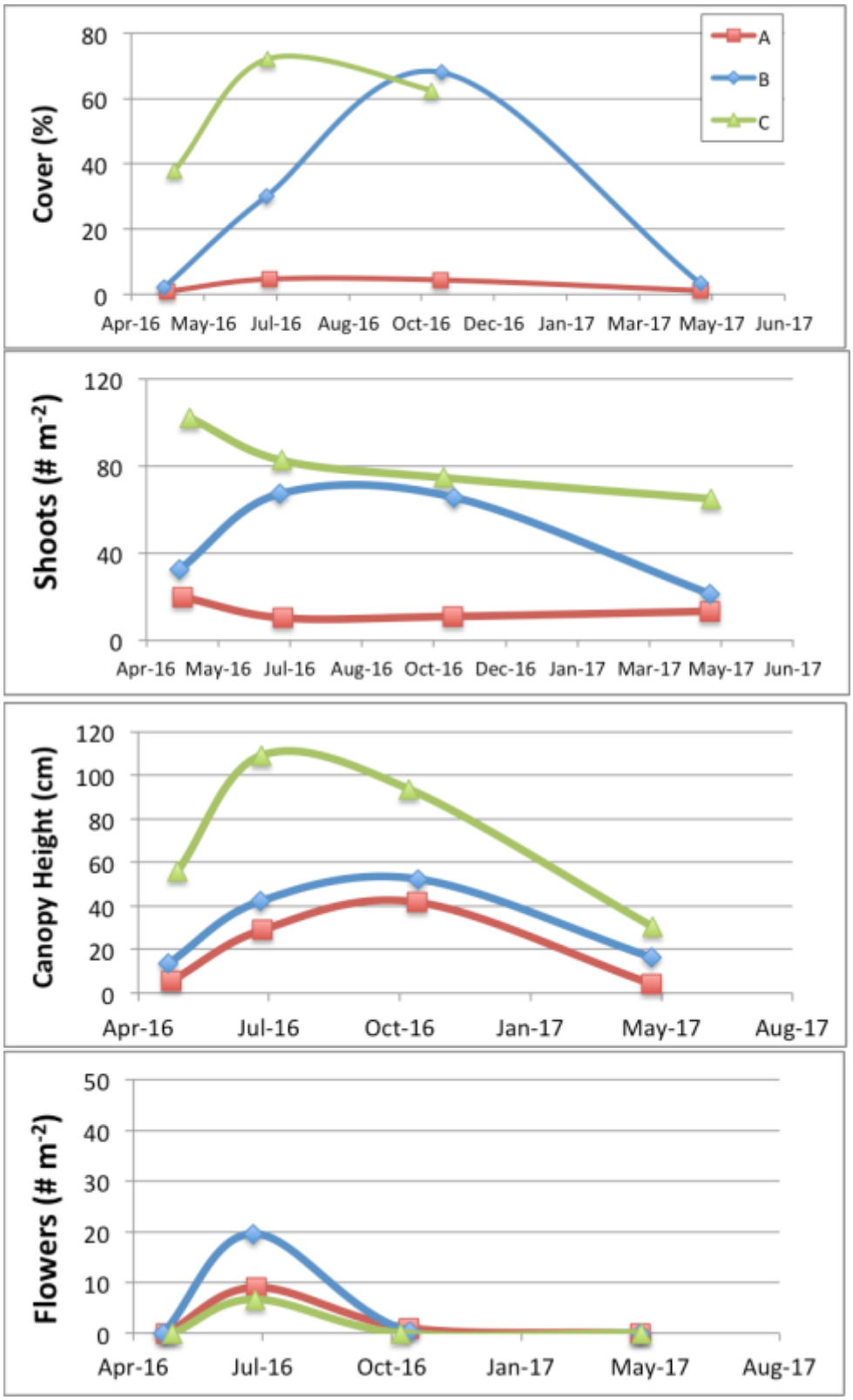


Figure 4. Eelgrass percent cover, shoot density, canopy height and flower density at SeagrassNet site NH9.2, Transects A, B, and C in Great Bay for April 2016 – April 2017; as a frame of reference and to extend the data to the next year, the April 2017 SeagrassNet data is included.

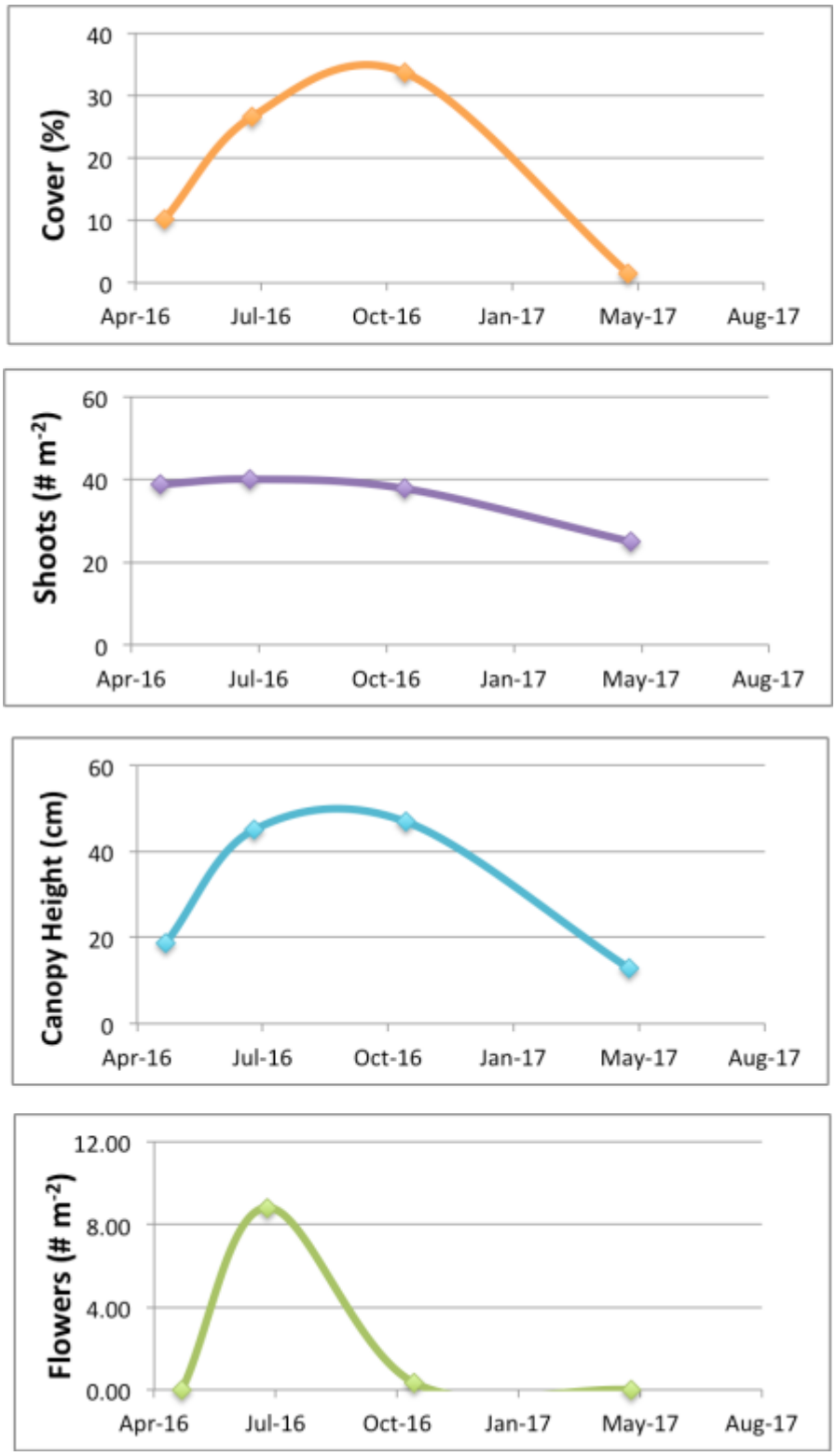


Figure 5. Eelgrass percent cover, shoot density, canopy height and flower density for Great Bay at SeagrassNet site NH9.2, for April 2016 – April 2017 (means of data for Transects A, B, and C); as a frame of reference and to extend the data to the next year, the April 2017 SeagrassNet data is included.

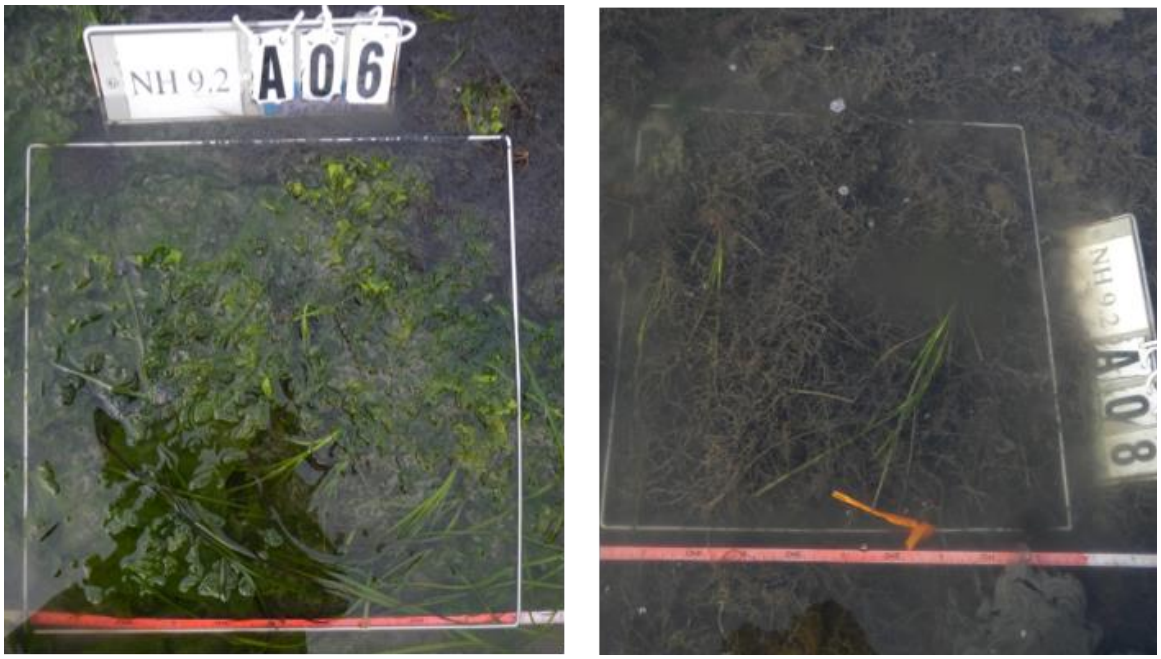
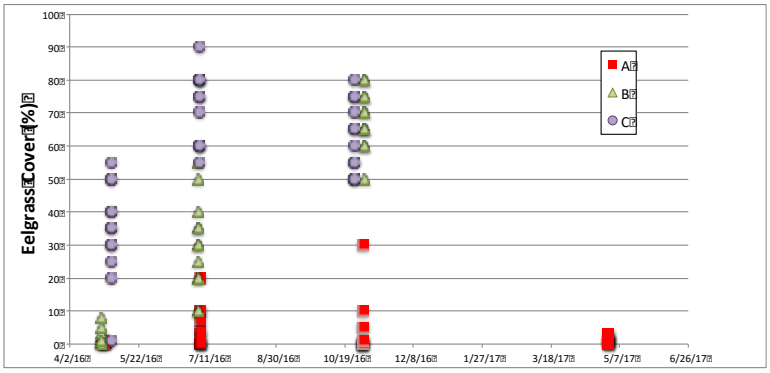
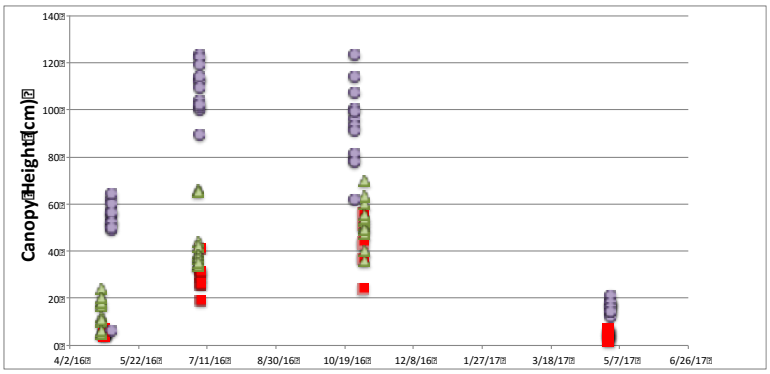


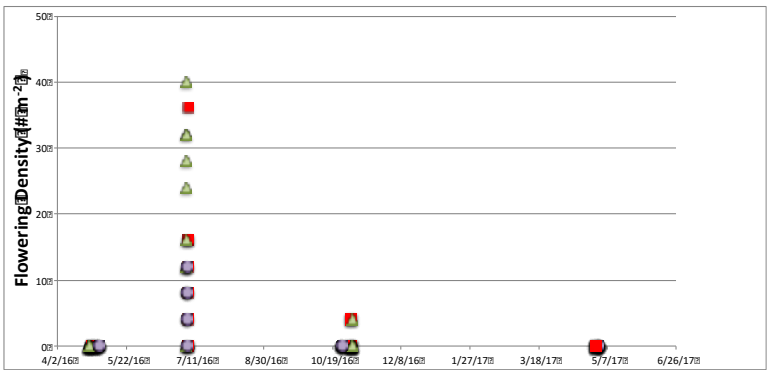
Figure 6. October 2014 (left) and October 2016 (right) examples of a quadrat photo on Transect A with different seaweed smothering the eelgrass. *Ulva lactuca* in 2014 and *Gracilaria vermicuphyllum* in 2016.

Appendix 1

Eelgrass percent cover, shoot density, and canopy height at SeagrassNet site NH9.2, Transects A, B, and C in Great Bay for April 2016 – April 2017.



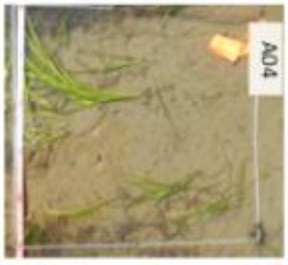
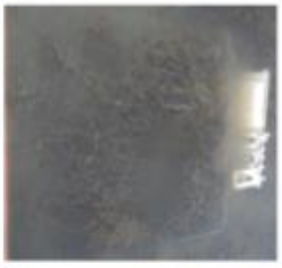
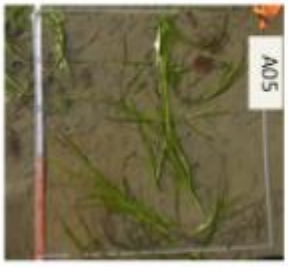
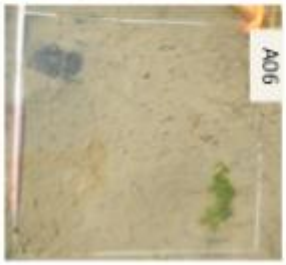




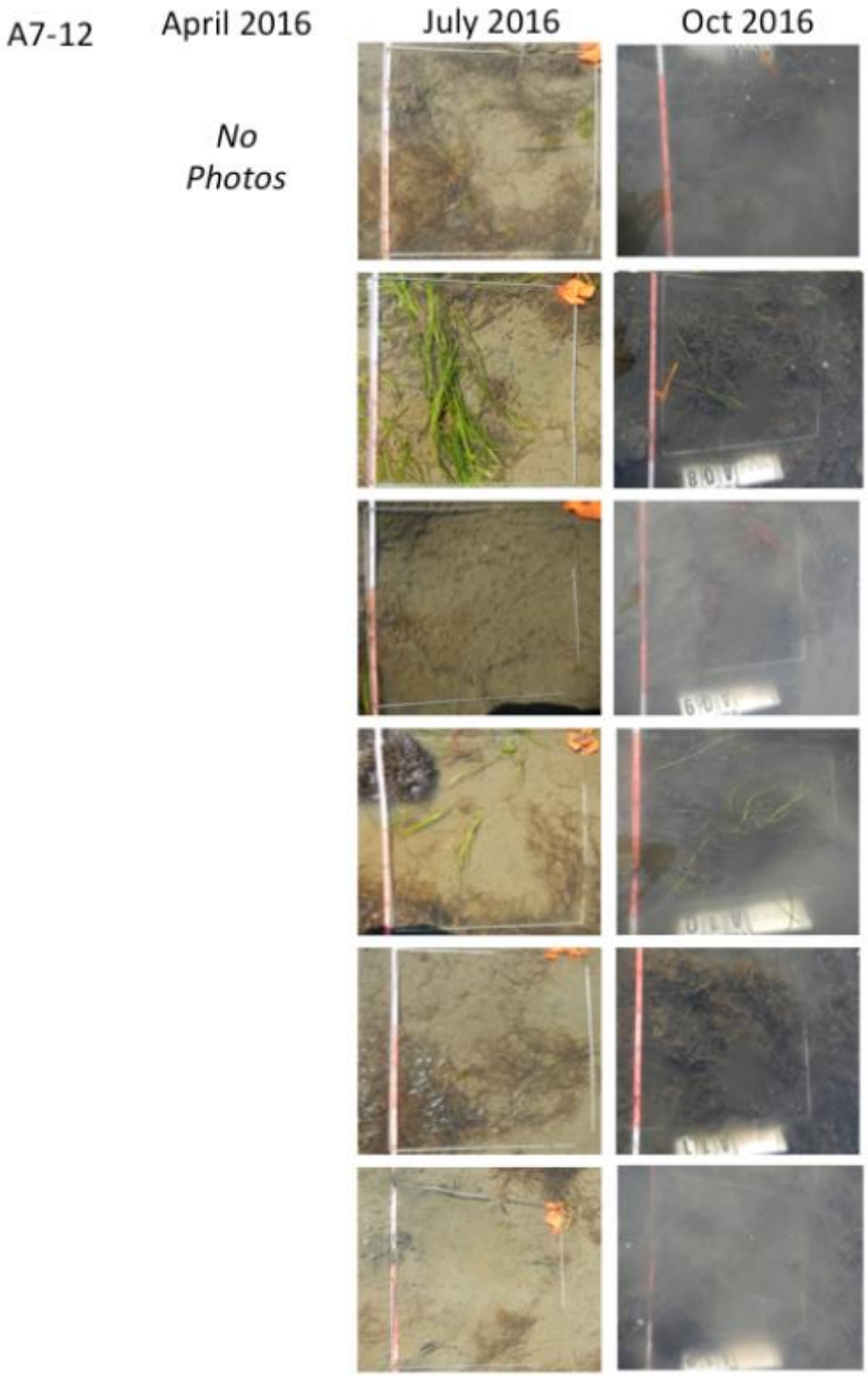
Appendix 2

Photo mosaic of quadrat photos from the 3 SeagrassNet transects (A, B, and C) taken during April, July and October 2016 in Great Bay, New Hampshire. The photos are organized so that columns represent the month the photographs were taken while the rows show the 12 replicates along each of the three transects (A, B, and C) over two pages.

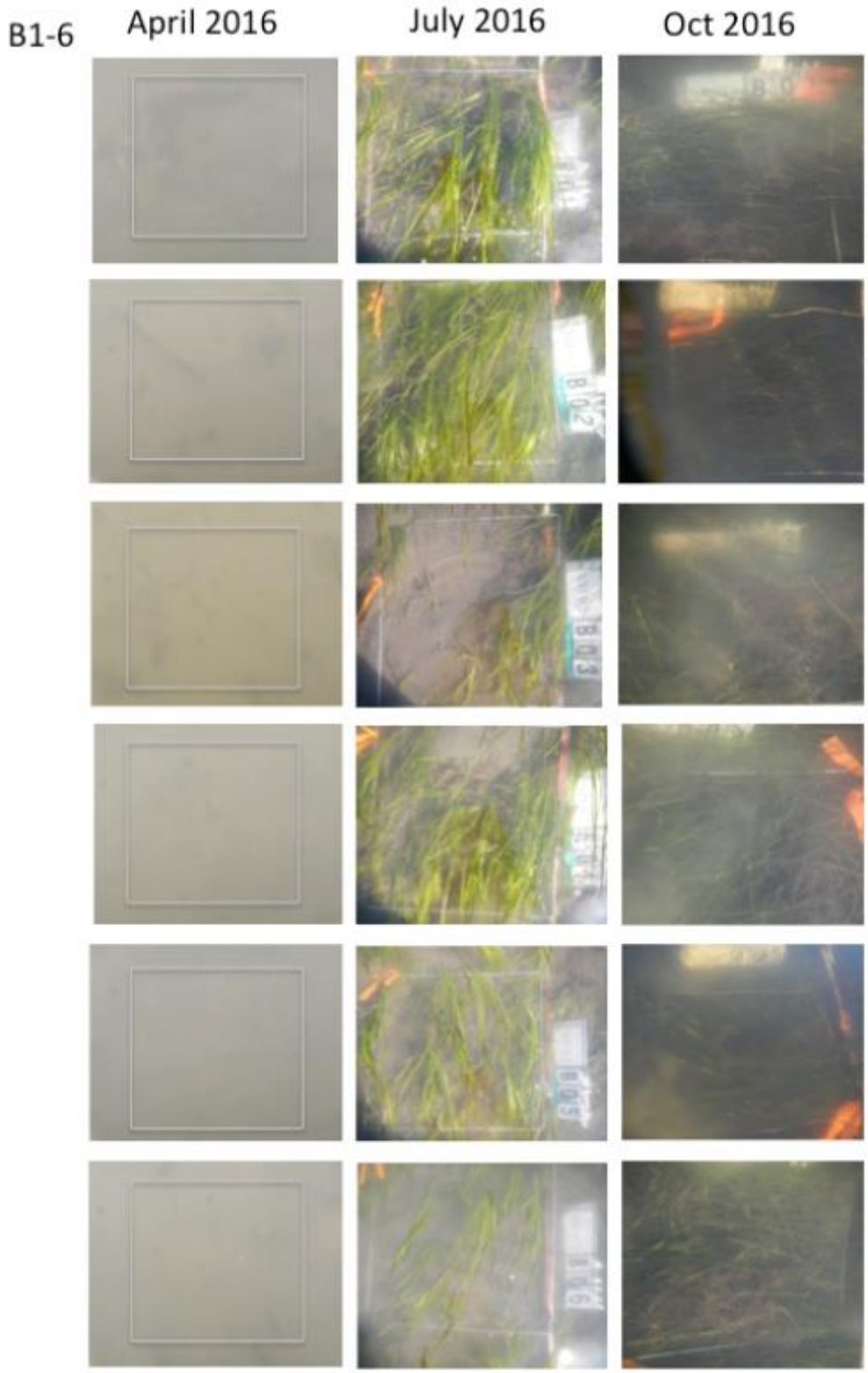
Appendix 2, Transect A, Quadrats 1 - 6

A1-6	April 2016	July 2016	OCT 2016
	No Photos		
			
			
			
			
			

Appendix 2, Transect A, Quadrats 7 – 12

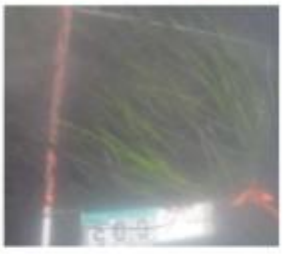


Appendix 2, Transect B, Quadrats 1 - 6



Appendix 2, Transect B, Quadrats 7 - 12

Appendix 2, Transect C, Quadrats 1 – 6

C1-6	April 2016	July 2016	Oct 2016
	No Photos		
			
			
			
			
			

Appendix 2, Transect C, Quadrats 7 – 12

C7-12	April 2016	July 2016	Oct 2016
	No Photos		
			
			
			
			
			

Appendix 3

Data table for SeagrassNet samples in Great Bay, NH April, July and October 2016 and April 2017. "Zm" represents *Zostera marina*, eelgrass. Blanks indicate no data while zeros indicate values of zero.

Location	Site	Transect	Quadrat #	Species	Date	Percent Cover (%)	Shoot Density (# m^{-2})	Canopy Height (cm)	Flowers (# m^{-2})
New Hampshire / Great Bay	NH9.2	A	1	Zm	4/27/16	1	16	6	0
New Hampshire / Great Bay	NH9.2	A	2	Zm	4/27/16	1	8	4	0
New Hampshire / Great Bay	NH9.2	A	3	Zm	4/27/16	0	0		0
New Hampshire / Great Bay	NH9.2	A	4	Zm	4/27/16	1	12	5	0
New Hampshire / Great Bay	NH9.2	A	5	Zm	4/27/16	1	16	6	0
New Hampshire / Great Bay	NH9.2	A	6	Zm	4/27/16	1	8	7	0
New Hampshire / Great Bay	NH9.2	A	7	Zm	4/27/16	1	20	5	0
New Hampshire / Great Bay	NH9.2	A	8	Zm	4/27/16	1	40	5	0
New Hampshire / Great Bay	NH9.2	A	9	Zm	4/27/16	1	12	6	0
New Hampshire / Great Bay	NH9.2	A	10	Zm	4/27/16	1	40	5	0
New Hampshire / Great Bay	NH9.2	A	11	Zm	4/27/16	1	20	5	0
New Hampshire / Great Bay	NH9.2	A	12	Zm	4/27/16	1	48	5	0
New Hampshire / Great Bay	NH9.2	B	1	Zm	4/25/16	1	36	24	0
New Hampshire / Great Bay	NH9.2	B	2	Zm	4/25/16	1	20	19	0
New Hampshire / Great Bay	NH9.2	B	3	Zm	4/25/16	0	0		0
New Hampshire / Great Bay	NH9.2	B	4	Zm	4/25/16	2	24	17	0
New Hampshire / Great Bay	NH9.2	B	5	Zm	4/25/16	1	4	18	0
New Hampshire / Great Bay	NH9.2	B	6	Zm	4/25/16	1	20	12	0
New Hampshire / Great Bay	NH9.2	B	7	Zm	4/25/16	1	16	5	0
New Hampshire / Great Bay	NH9.2	B	8	Zm	4/25/16	2	32	10	0
New Hampshire / Great Bay	NH9.2	B	9	Zm	4/25/16	3	52	5	0
New Hampshire / Great Bay	NH9.2	B	10	Zm	4/25/16	5	108	11	0
New Hampshire / Great Bay	NH9.2	B	11	Zm	4/25/16	8	48	20	0
New Hampshire / Great Bay	NH9.2	B	12	Zm	4/25/16	1	32	6	0
New Hampshire / Great Bay	NH9.2	C	1	Zm	5/2/16	25	80	55	0
New Hampshire / Great Bay	NH9.2	C	2	Zm	5/2/16	50	144	53	0
New Hampshire / Great Bay	NH9.2	C	3	Zm	5/2/16	30	104	57	0
New Hampshire / Great Bay	NH9.2	C	4	Zm	5/2/16	30	72	62	0
New Hampshire / Great Bay	NH9.2	C	5	Zm	5/2/16	20	92	52	0
New Hampshire / Great Bay	NH9.2	C	6	Zm	5/2/16	35	72	49	0
New Hampshire / Great Bay	NH9.2	C	7	Zm	5/2/16	35	108	60	0
New Hampshire / Great Bay	NH9.2	C	8	Zm	5/2/16	50	96	56	0
New Hampshire / Great Bay	NH9.2	C	9	Zm	5/2/16	40	76	52	0
New Hampshire / Great Bay	NH9.2	C	10	Zm	5/2/16	55	140	50	0
New Hampshire / Great Bay	NH9.2	C	11	Zm	5/2/16	40	108	64	0

New Hampshire / Great Bay	NH9.2	C	12	Zm	5/2/16	45	136	61	0
New Hampshire / Great Bay	NH9.2	A	1	Zm	7/6/16	10	20	31	12
New Hampshire / Great Bay	NH9.2	A	2	Zm	7/6/16	4	8	19	8
New Hampshire / Great Bay	NH9.2	A	3	Zm	7/6/16	3	4	26	4
New Hampshire / Great Bay	NH9.2	A	4	Zm	7/6/16	7	20	29	16
New Hampshire / Great Bay	NH9.2	A	5	Zm	7/6/16	10	20	26	16
New Hampshire / Great Bay	NH9.2	A	6	Zm	7/6/16	0	0		0
New Hampshire / Great Bay	NH9.2	A	7	Zm	7/6/16	0	0		0
New Hampshire / Great Bay	NH9.2	A	8	Zm	7/6/16	20	36	41	36
New Hampshire / Great Bay	NH9.2	A	9	Zm	7/6/16	0	0		0
New Hampshire / Great Bay	NH9.2	A	10	Zm	7/6/16	2	16	31	16
New Hampshire / Great Bay	NH9.2	A	11	Zm	7/6/16	0	0		0
New Hampshire / Great Bay	NH9.2	A	12	Zm	7/6/16	0	0		0
New Hampshire / Great Bay	NH9.2	B	1	Zm	7/4/16	50	88	66	0
New Hampshire / Great Bay	NH9.2	B	2	Zm	7/4/16	35	56	65	0
New Hampshire / Great Bay	NH9.2	B	3	Zm	7/4/16	10	36	44	12
New Hampshire / Great Bay	NH9.2	B	4	Zm	7/4/16	40	84	39	
New Hampshire / Great Bay	NH9.2	B	5	Zm	7/4/16	30	60	42	28
New Hampshire / Great Bay	NH9.2	B	6	Zm	7/4/16	20	68	34	24
New Hampshire / Great Bay	NH9.2	B	7	Zm	7/4/16	35	84	37	16
New Hampshire / Great Bay	NH9.2	B	8	Zm	7/4/16	25	88	34	32
New Hampshire / Great Bay	NH9.2	B	9	Zm	7/4/16	30	72	34	32
New Hampshire / Great Bay	NH9.2	B	10	Zm	7/4/16	55	112	38	40
New Hampshire / Great Bay	NH9.2	B	11	Zm	7/4/16	20	40	37	
New Hampshire / Great Bay	NH9.2	B	12	Zm	7/4/16	10	20	35	12
New Hampshire / Great Bay	NH9.2	C	1	Zm	7/5/16	70	96	100	12
New Hampshire / Great Bay	NH9.2	C	2	Zm	7/5/16	55	56	101	4
New Hampshire / Great Bay	NH9.2	C	3	Zm	7/5/16	80	136	104	8
New Hampshire / Great Bay	NH9.2	C	4	Zm	7/5/16	60	72	113	0
New Hampshire / Great Bay	NH9.2	C	5	Zm	7/5/16	75	48	112	8
New Hampshire / Great Bay	NH9.2	C	6	Zm	7/5/16	80	104	114	4
New Hampshire / Great Bay	NH9.2	C	7	Zm	7/5/16	60	76	89	0
New Hampshire / Great Bay	NH9.2	C	8	Zm	7/5/16	80	60	102	4
New Hampshire / Great Bay	NH9.2	C	9	Zm	7/5/16	80	96	109	12
New Hampshire / Great Bay	NH9.2	C	10	Zm	7/5/16	75	84	123	8
New Hampshire / Great Bay	NH9.2	C	11	Zm	7/5/16	90	112	122	12
New Hampshire / Great Bay	NH9.2	C	12	Zm	7/5/16	60	52	119	8
New Hampshire / Great Bay	NH9.2	A	1	Zm	11/1/16	0	0		0
New Hampshire / Great Bay	NH9.2	A	2	Zm	11/1/16	10	28	37	0
New Hampshire / Great Bay	NH9.2	A	3	Zm	11/1/16	1	4	43	0
New Hampshire / Great Bay	NH9.2	A	4	Zm	11/1/16	0	0		0
New Hampshire / Great Bay	NH9.2	A	5	Zm	11/1/16	5	16	51	4
New Hampshire / Great Bay	NH9.2	A	6	Zm	11/1/16	0	0		0

New Hampshire / Great Bay	NH9.2	A	7	Zm	11/1/16	0	0		0
New Hampshire / Great Bay	NH9.2	A	8	Zm	11/1/16	5	24	37	4
New Hampshire / Great Bay	NH9.2	A	9	Zm	11/1/16	1	4	24	0
New Hampshire / Great Bay	NH9.2	A	10	Zm	11/1/16	30	52	44	4
New Hampshire / Great Bay	NH9.2	A	11	Zm	11/1/16	0	0		0
New Hampshire / Great Bay	NH9.2	A	12	Zm	11/1/16	1	4	56	0
New Hampshire / Great Bay	NH9.2	B	1	Zm	11/2/16	80	64	36	0
New Hampshire / Great Bay	NH9.2	B	2	Zm	11/2/16	70	72	47	0
New Hampshire / Great Bay	NH9.2	B	3	Zm	11/2/16	60	40	60	0
New Hampshire / Great Bay	NH9.2	B	4	Zm	11/2/16	80	104	63	0
New Hampshire / Great Bay	NH9.2	B	5	Zm	11/2/16	50	52	51	0
New Hampshire / Great Bay	NH9.2	B	6	Zm	11/2/16	65	48	70	0
New Hampshire / Great Bay	NH9.2	B	7	Zm	11/2/16	65	64	50	0
New Hampshire / Great Bay	NH9.2	B	8	Zm	11/2/16	75	72	40	0
New Hampshire / Great Bay	NH9.2	B	9	Zm	11/2/16	70	92	53	0
New Hampshire / Great Bay	NH9.2	B	10	Zm	11/2/16	60	48	49	4
New Hampshire / Great Bay	NH9.2	B	11	Zm	11/2/16	65	72	54	0
New Hampshire / Great Bay	NH9.2	B	12	Zm	11/2/16	75	60	55	0
New Hampshire / Great Bay	NH9.2	C	1	Zm	10/26/16	65	64	79	0
New Hampshire / Great Bay	NH9.2	C	2	Zm	10/26/16	80	104	96	0
New Hampshire / Great Bay	NH9.2	C	3	Zm	10/26/16	75	72	107	0
New Hampshire / Great Bay	NH9.2	C	4	Zm	10/26/16	70	92	93	0
New Hampshire / Great Bay	NH9.2	C	5	Zm	10/26/16	60	56	100	0
New Hampshire / Great Bay	NH9.2	C	6	Zm	10/26/16	55	48	81	0
New Hampshire / Great Bay	NH9.2	C	7	Zm	10/26/16	55	44	91	0
New Hampshire / Great Bay	NH9.2	C	8	Zm	10/26/16	75	108	78	0
New Hampshire / Great Bay	NH9.2	C	9	Zm	10/26/16	50	68	99	0
New Hampshire / Great Bay	NH9.2	C	10	Zm	10/26/16	50	76	62	0
New Hampshire / Great Bay	NH9.2	C	11	Zm	10/26/16	65	96	114	0
New Hampshire / Great Bay	NH9.2	C	12	Zm	10/26/16	50	68	123	0
New Hampshire / Great Bay	NH9.2	A	1	Zm	4/29/17	0	0		0
New Hampshire / Great Bay	NH9.2	A	2	Zm	4/29/17	3	12	4	0
New Hampshire / Great Bay	NH9.2	A	3	Zm	4/29/17	1	12	3	0
New Hampshire / Great Bay	NH9.2	A	4	Zm	4/29/17	1	12	3	0
New Hampshire / Great Bay	NH9.2	A	5	Zm	4/29/17	1	4	2	0
New Hampshire / Great Bay	NH9.2	A	6	Zm	4/29/17	0	0		0
New Hampshire / Great Bay	NH9.2	A	7	Zm	4/29/17	2	24	5	0
New Hampshire / Great Bay	NH9.2	A	8	Zm	4/29/17	2	28	5	0
New Hampshire / Great Bay	NH9.2	A	9	Zm	4/29/17	1	8	4	0
New Hampshire / Great Bay	NH9.2	A	10	Zm	4/29/17	1	16	5	0
New Hampshire / Great Bay	NH9.2	A	11	Zm	4/29/17	1	32	7	0
New Hampshire / Great Bay	NH9.2	A	12	Zm	4/29/17	1	12	5	0
New Hampshire / Great Bay	NH9.2	B	1	Zm	4/30/17	15	52	15	0

New Hampshire / Great Bay	NH9.2	B	2	Zm	4/30/17	1	12	17	0
New Hampshire / Great Bay	NH9.2	B	3	Zm	4/30/17	1	8	12	0
New Hampshire / Great Bay	NH9.2	B	4	Zm	4/30/17	2	16	18	0
New Hampshire / Great Bay	NH9.2	B	5	Zm	4/30/17	3	20	19	0
New Hampshire / Great Bay	NH9.2	B	6	Zm	4/30/17	3	20	17	0
New Hampshire / Great Bay	NH9.2	B	7	Zm	4/30/17	1	4	14	0
New Hampshire / Great Bay	NH9.2	B	8	Zm	4/30/17	1	32	17	0
New Hampshire / Great Bay	NH9.2	B	9	Zm	4/30/17	2	16	21	0
New Hampshire / Great Bay	NH9.2	B	10	Zm	4/30/17	3	24	18	0
New Hampshire / Great Bay	NH9.2	B	11	Zm	4/30/17	3	24	16	0
New Hampshire / Great Bay	NH9.2	B	12	Zm	4/30/17	5	28	14	0
New Hampshire / Great Bay	NH9.2	C	1	Zm	4/29/17		100	35	0
New Hampshire / Great Bay	NH9.2	C	2	Zm	4/29/17		44	24	0
New Hampshire / Great Bay	NH9.2	C	3	Zm	4/29/17		76	34	0
New Hampshire / Great Bay	NH9.2	C	4	Zm	4/29/17		36	27	0
New Hampshire / Great Bay	NH9.2	C	5	Zm	4/29/17		56	29	0
New Hampshire / Great Bay	NH9.2	C	6	Zm	4/29/17		36	42	0
New Hampshire / Great Bay	NH9.2	C	7	Zm	4/29/17		68	34	0
New Hampshire / Great Bay	NH9.2	C	8	Zm	4/29/17		44	27	0
New Hampshire / Great Bay	NH9.2	C	9	Zm	4/29/17		32	26	0
New Hampshire / Great Bay	NH9.2	C	10	Zm	4/29/17		104	31	0
New Hampshire / Great Bay	NH9.2	C	11	Zm	4/29/17		136	23	0
New Hampshire / Great Bay	NH9.2	C	12	Zm	4/29/17		48	34	0